# Supplemental Material

Air Pollution and Emergency Department Visits for Otitis Media: A Case-Crossover Study in Edmonton, Canada

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## 1. The results for the data restricted to first ED visits for OM

The below presented tables (Supplemental Material, Table 1 and 2) correspond to Table 3 and 4, and show the results for data restricted to patients' first visits between ages 1-3 years. The visits were sorted by date and first time registered visit were used. The results may be considered as a sensitivity analysis.

Supplemental Material, Table 1. Male patients (first visits only): The associations between pollutants and ED visits for OM based on lag times (days), by months.

| | | All months | | Warm months | | Cold months | |
|---|---|---|---|---|---|---|---|
| Pollutant | Lag | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| CO | 0 | 0.99 | 0.95, 1.02 | 1.06 | 0.94, 1.20 | 0.98 | 0.94, 1.02 |
| | 1 | 0.98 | 0.94, 1.01 | 1.12 | 0.99, 1.26 | 0.96 | 0.93, 1.00 |
| | 2 | 1.02 | 0.98, 1.05 | 1.23 | 1.09, 1.38[a] | 1.00 | 0.96, 1.03 |
| | 3 | 1.01 | 0.97, 1.04 | 1.10 | 0.96, 1.25 | 1.00 | 0.96, 1.04 |
| | 4 | 1.01 | 0.97, 1.04 | 1.13 | 1.00, 1.28[a] | 1.00 | 0.96, 1.03 |
| $NO_2$ | 0 | 0.97 | 0.92, 1.02 | 0.95 | 0.84, 1.08 | 0.97 | 0.92, 1.03 |
| | 1 | 0.96 | 0.91, 1.01 | 0.98 | 0.87, 1.12 | 0.96 | 0.90, 1.01 |
| | 2 | 1.04 | 0.98, 1.09 | 1.04 | 0.92, 1.18 | 1.03 | 0.98, 1.09 |
| | 3 | 1.00 | 0.95, 1.05 | 1.01 | 0.89, 1.14 | 1.00 | 0.94, 1.05 |
| | 4 | 0.98 | 0.94, 1.04 | 1.00 | 0.88, 1.13 | 0.98 | 0.93, 1.04 |
| $SO_2$ | 0 | 0.99 | 0.95, 1.04 | 0.98 | 0.91, 1.06 | 1.00 | 0.95, 1.05 |
| | 1 | 0.97 | 0.93, 1.01 | 1.00 | 0.93, 1.08 | 0.96 | 0.91, 1.01 |
| | 2 | 0.97 | 0.93, 1.01 | 0.98 | 0.91, 1.05 | 0.97 | 0.92, 1.01 |
| | 3 | 1.00 | 0.96, 1.04 | 1.05 | 0.98, 1.13 | 0.97 | 0.92, 1.02 |
| | 4 | 1.01 | 0.97, 1.05 | 1.03 | 0.95, 1.11 | 1.00 | 0.95, 1.05 |
| $O_3$ | 0 | 1.10 | 1.02, 1.18[a] | 1.06 | 0.94, 1.21 | 1.13 | 1.03, 1.24[a] |
| | 1 | 1.07 | 0.99, 1.15 | 0.95 | 0.83, 1.08 | 1.15 | 1.05, 1.26[a] |
| | 2 | 0.98 | 0.91, 1.06 | 0.94 | 0.82, 1.07 | 1.03 | 0.94, 1.12 |
| | 3 | 1.03 | 0.96, 1.11 | 1.00 | 0.87, 1.14 | 1.06 | 0.97, 1.16 |
| | 4 | 1.03 | 0.96, 1.11 | 0.99 | 0.87, 1.13 | 1.06 | 0.97, 1.16 |
| $PM_{10}$ | 0 | 1.02 | 0.97, 1.06 | 1.05 | 0.98, 1.12 | 1.00 | 0.94, 1.06 |
| | 1 | 0.98 | 0.94, 1.03 | 1.04 | 0.97, 1.12 | 0.95 | 0.89, 1.01 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 1.00 | 0.96, 1.05 | 1.04 | 0.96, 1.12 | 1.00 | 0.94, 1.06 |
| | 3 | 0.98 | 0.94, 1.03 | 1.04 | 0.96, 1.12 | 0.96 | 0.91, 1.02 |
| | 4 | 1.00 | 0.96, 1.05 | 1.03 | 0.96, 1.11 | 1.00 | 0.94, 1.06 |
| $PM_{2.5}$ | 0 | 1.02 | 0.97, 1.08 | 1.07 | 0.99, 1.15 | 1.00 | 0.93, 1.08 |
| | 1 | 0.99 | 0.93, 1.04 | 1.06 | 0.97, 1.15 | 0.96 | 0.89, 1.03 |
| | 2 | 0.94 | 0.88, 0.99[a] | 0.95 | 0.85, 1.05 | 0.95 | 0.88, 1.02 |
| | 3 | 0.93 | 0.88, 0.98[a] | 0.94 | 0.85, 1.04 | 0.93 | 0.87, 1.00 |
| | 4 | 0.98 | 0.93, 1.03 | 1.01 | 0.93, 1.10 | 0.95 | 0.89, 1.03 |

[a] Significant at the 5 % level.

Note: OR = odds ratios; CI = confidence intervals; CO = carbon monoxide; $NO_2$ = nitrogen dioxide; $SO_2$ = sulphur dioxide; $O_3$ = ozone; PM = particulate matter. The results are reported for the IQRs listed in Table 1. (Warm: April – September, cold: October – March).

Supplemental Material, Table 2. Female patients (first visits only): The associations between pollutants and ED visits for OM based on lag times (days), by months.

| | | All months | | Warm months | | Cold months | |
|---|---|---|---|---|---|---|---|
| Pollutant | Lag | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| CO | 0 | 0.98 | 0.94, 1.01 | 0.99 | 0.86, 1.15 | 0.97 | 0.93, 1.01 |
| | 1 | 0.99 | 0.96, 1.03 | 1.02 | 0.88, 1.17 | 0.99 | 0.95, 1.03 |
| | 2 | 1.03 | 0.99, 1.07 | 1.11 | 0.96, 1.27 | 1.02 | 0.98, 1.06 |
| | 3 | 1.02 | 0.99, 1.06 | 1.16 | 1.01, 1.34[a] | 1.01 | 0.97, 1.05 |
| | 4 | 1.01 | 0.97, 1.05 | 1.06 | 0.92, 1.22 | 1.01 | 0.97, 1.04 |
| $NO_2$ | 0 | 0.98 | 0.93, 1.04 | 1.05 | 0.91, 1.21 | 0.97 | 0.91, 1.03 |
| | 1 | 1.00 | 0.95, 1.06 | 1.08 | 0.94, 1.24 | 0.99 | 0.93, 1.05 |
| | 2 | 1.04 | 0.98, 1.10 | 1.19 | 1.04, 1.37[a] | 1.01 | 0.95, 1.08 |
| | 3 | 1.02 | 0.96, 1.08 | 1.19 | 1.04, 1.37[a] | 0.99 | 0.93, 1.05 |
| | 4 | 0.99 | 0.94, 1.05 | 1.01 | 0.88, 1.17 | 0.99 | 0.93, 1.05 |
| $SO_2$ | 0 | 0.98 | 0.93, 1.02 | 0.99 | 0.91, 1.08 | 0.97 | 0.92, 1.02 |
| | 1 | 1.01 | 0.96, 1.05 | 0.99 | 0.91, 1.08 | 1.01 | 0.95, 1.06 |
| | 2 | 1.00 | 0.95, 1.04 | 1.02 | 0.94, 1.11 | 0.99 | 0.94, 1.04 |
| | 3 | 1.02 | 0.97, 1.07 | 1.03 | 0.95, 1.12 | 1.01 | 0.96, 1.06 |
| | 4 | 1.00 | 0.96, 1.05 | 1.03 | 0.95, 1.13 | 0.99 | 0.94, 1.05 |
| $O_3$ | 0 | 1.01 | 0.93, 1.09 | 1.04 | 0.90, 1.20 | 1.01 | 0.91, 1.11 |
| | 1 | 1.03 | 0.95, 1.11 | 1.13 | 0.98, 1.31 | 1.00 | 0.91, 1.10 |
| | 2 | 0.96 | 0.89, 1.05 | 1.00 | 0.86, 1.16 | 0.95 | 0.86, 1.05 |
| | 3 | 0.97 | 0.90, 1.05 | 0.95 | 0.82, 1.10 | 1.00 | 0.91, 1.11 |
| | 4 | 1.01 | 0.93, 1.09 | 1.05 | 0.91, 1.21 | 1.00 | 0.91, 1.11 |
| $PM_{10}$ | 0 | 0.97 | 0.92, 1.02 | 1.04 | 0.96, 1.13 | 0.93 | 0.87, 1.00 |
| | 1 | 0.99 | 0.94, 1.04 | 1.04 | 0.95, 1.13 | 0.97 | 0.91, 1.04 |
| | 2 | 1.02 | 0.97, 1.07 | 1.06 | 0.98, 1.15 | 0.99 | 0.92, 1.06 |
| | 3 | 1.00 | 0.95, 1.05 | 1.08 | 1.00, 1.17[a] | 0.98 | 0.92, 1.04 |
| | 4 | 1.03 | 0.98, 1.08 | 1.10 | 1.02, 1.19[a] | 1.00 | 0.94, 1.06 |
| $PM_{2.5}$ | 0 | 0.97 | 0.91, 1.03 | 0.99 | 0.90, 1.10 | 0.97 | 0.89, 1.06 |
| | 1 | 0.96 | 0.90, 1.02 | 0.97 | 0.88, 1.08 | 0.96 | 0.88, 1.04 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 2 | 1.00 | 0.95, 1.06 | 1.04 | 0.97, 1.13 | 0.97 | 0.89, 1.06 |
| 3 | 0.98 | 0.93, 1.04 | 1.04 | 0.95, 1.15 | 0.97 | 0.90, 1.06 |
| 4 | 1.03 | 0.97, 1.09 | 1.09 | 1.00, 1.19[a] | 1.00 | 0.93, 1.08 |

[a] Significant at the 5 % level.
Note: OR = odds ratios; CI = confidence intervals; CO = carbon monoxide; $NO_2$ = nitrogen dioxide; $SO_2$ = sulphur dioxide; $O_3$ = ozone; PM = particulate matter. The results are reported for the IQRs listed in Table 1. (Warm: April – September, cold: October – March).

## 2. Multi-pollutant and cumulative exposure models

Concerning the confounding problem, which embraces the question which variables should be included into regression models, we re-computed odds estimators with multi-pollutant models for all variables positively associated with presentations of otitis media, and applying all combinations of predictors. This involved three variables—CO, $NO_2$, and $O_3$—and six multi-pollutant models. However, due to a high correlation between the variables CO and $NO_2$ (0.78), the models including both CO and $NO_2$ may give unrealistic results and therefore should be discarded. The model $NO_2 + O_3$ did not show better performance, at least in the sense of model fit statistics than the one pollutant models. Only the model $CO + O_3$ satisfied the fitting tests better than the one-pollutant models; the estimations produced with that model are shown in Supplemental Material, Table 3.

Supplemental Material, Table 3. Results obtained with two-pollutant model $CO + O_3$.

| | | Male patients in warm months | | Female patients in warm months | | Male patients in cold months | |
|---|---|---|---|---|---|---|---|
| Pollutant | Lag | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| CO | 0 | 1.12 | 1.01, 1.25[a] | 0.96 | 0.84, 1.09 | 1.01 | 0.97, 1.06 |
| | 1 | 1.14 | 1.02, 1.27[a] | 1.05 | 0.93, 1.20 | 1.00 | 0.96, 1.04 |
| | 2 | 1.19 | 1.06, 1.32[a] | 1.13 | 1.00, 1.28[a] | 1.01 | 0.97, 1.05 |
| | 3 | 1.11 | 1.00, 1.25[a] | 1.09 | 0.95, 1.24 | 1.02 | 0.98, 1.06 |
| | 4 | 1.13 | 1.01, 1.26[a] | 1.05 | 0.92, 1.19 | 1.02 | 0.98, 1.06 |
| $O_3$ | 0 | 1.17 | 1.04, 1.30[a] | 1.01 | 0.88, 1.15 | 1.11 | 1.00, 1.23[a] |
| | 1 | 1.02 | 0.91, 1.15 | 1.08 | 0.95, 1.24 | 1.12 | 1.01, 1.24[a] |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 1.05 | 0.93, 1.18 | 1.03 | 0.90, 1.19 | 1.04 | 0.94, 1.15 |
| | 3 | 1.10 | 0.97, 1.24 | 1.03 | 0.89, 1.18 | 1.10 | 0.99, 1.22 |
| | 4 | 1.03 | 0.92, 1.17 | 1.12 | 0.98, 1.29 | 1.10 | 0.99, 1.22 |

[a] Significant at the 5 % level.
Note: OR = odds ratios; CI = confidence intervals; CO = carbon monoxide; $O_3$ = ozone. The results are reported for the IQRs listed in Table 1. (Warm: April – September, cold: October – March).

While particulate matter showed inconsistent associations with ED presentations of otitis media ($PM_{10}$ was positive in warm seasons, none with $PM_{2.5}$), multi-pollutant models suggest that same-day effects ascribed to CO or $O_3$ may in fact be linked to $PM_{2.5}$. Supplemental Material, Table 4 shows reproduction of the results from Supplemental Material, Table 3 when the predictor $PM_{2.5}$ is added to the model. It is to be noted that only about 40% of all observations were available in evaluation of the model CO + $O_3$ + $PM_{2.5}$, as PM data were not complete.

Supplemental Material, Table 4. Results obtained with three-pollutant model CO + $O_3$ + $PM_{2.5}$.

| | | Male patients in warm months | | Female patients in warm months | | Male patients in cold months | |
|---|---|---|---|---|---|---|---|
| Pollutant | Lag | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| CO | 0 | 0.90 | 0.69, 1.18 | 0.92 | 0.68, 1.23 | 0.92 | 0.83, 1.03 |
| | 1 | 1.00 | 0.77, 1.30 | 1.27 | 0.96, 1.69 | 0.97 | 0.86, 1.08 |
| | 2 | 1.31 | 1.01, 1.69[a] | 1.22 | 0.92, 1.63 | 1.05 | 0.94, 1.17 |
| | 3 | 1.28 | 0.97, 1.69 | 1.16 | 0.86, 1.56 | 1.00 | 0.90, 1.11 |
| | 4 | 1.41 | 1.07, 1.85[a] | 1.13 | 0.83, 1.52 | 0.98 | 0.89, 1.09 |
| $O_3$ | 0 | 1.08 | 0.89, 1.31 | 0.91 | 0.73, 1.14 | 1.03 | 0.87, 1.22 |
| | 1 | 0.96 | 0.79, 1.17 | 1.23 | 0.99, 1.54 | 0.95 | 0.80, 1.13 |
| | 2 | 1.17 | 0.96, 1.43 | 1.21 | 0.96, 1.52 | 0.86 | 0.72, 1.03 |
| | 3 | 1.31 | 1.07, 1.60[a] | 1.13 | 0.90, 1.42 | 0.96 | 0.80, 1.14 |
| | 4 | 1.23 | 1.01, 1.51[a] | 1.17 | 0.93, 1.47 | 0.92 | 0.78, 1.09 |
| $PM_{2.5}$ | 0 | 1.06 | 0.98, 1.15 | 1.00 | 0.90, 1.11 | 1.11 | 1.00, 1.24[a] |
| | 1 | 1.07 | 0.98, 1.16 | 0.95 | 0.86, 1.05 | 0.99 | 0.89, 1.10 |

[a] Significant at the 5 % level.
Note: OR = odds ratios; CI = confidence intervals; CO = carbon monoxide; $O_3$ = ozone; $PM_{2.5}$ = particulate matter, particles of diameter <= 2.5 microns. The results are reported for the IQRs listed in Table 1. (Warm: April – September, cold: October – March).

We also assessed the dose-response relationship when the dose was defined as a cumulative exposure: average level of a pollutant on successive days (2 to 5 days). It appeared that there was less associations between the cumulative exposure and the health outcome, but those remaining were stronger and showed linear dependence on the dose measure. We concluded that the correlation between health outcome and short-term acute exposure was scrambled when constructing the doses and the association could not be captured. Supplemental Material, Table 5 brings together results obtained with all adequate models, potential predictors being accumulations of pollutants over 5 days, last day falling on the day of ED visit (lag 0). The accumulated doses were calculated as averages for 5 days.

Supplemental Material, Table 5. Results obtained with multi-pollutant models and 5-day cumulative exposure (lag 4 to lag 0).

| | | Male, Warm months | | Female, Warm months | | Male, Cold months | |
|---|---|---|---|---|---|---|---|
| Pollutant | Model | OR | 95% CI | OR | 95% CI | OR | 95% CI |
| CO | CO | 1.29 | 1.10, 1.52[a] | 1.08 | 0.89, 1.30 | 0.98 | 0.94, 1.03 |
| | CO+SO2 | 1.34 | 1.13, 1.60[a] | 1.07 | 0.88, 1.31 | 1.00 | 0.95, 1.06 |
| | CO+O3 | 1.31 | 1.10, 1.55[a] | 1.09 | 0.90, 1.33 | 1.04 | 0.98, 1.10 |
| | CO+SO2+O3 | 1.36 | 1.14, 1.63[a] | 1.09 | 0.89, 1.34 | 1.05 | 0.99, 1.12 |
| | CO+O3+PM2.5 | 1.31 | 0.87, 1.96 | 1.24 | 0.80, 1.90 | 1.01 | 0.86, 1.19 |
| NO2 | NO2 | 1.00 | 0.85, 1.18 | 1.21 | 1.00, 1.46[a] | 0.98 | 0.92, 1.06 |
| | NO2+O3 | 1.00 | 0.85, 1.18 | 1.21 | 1.01, 1.46[a] | 1.09 | 0.99, 1.20 |
| | NO2+SO2+O3 | 1.01 | 0.84, 1.21 | 1.23 | 1.00, 1.51[a] | 1.12 | 1.01, 1.24[a] |
| | NO2+O3+PM2.5 | 1.21 | 1.02, 1.43[a] | 1.00 | 0.70, 1.43 | 1.21 | 1.02, 1.43[a] |
| O3 | O3 | 0.98 | 0.85, 1.13 | 1.02 | 0.87, 1.20 | 1.20 | 1.06, 1.35[a] |
| | NO2+O3 | 0.98 | 0.85, 1.13 | 1.04 | 0.89, 1.22 | 1.32 | 1.12, 1.55[a] |
| | CO+O3 | 1.04 | 0.90, 1.21 | 1.05 | 0.89, 1.24 | 1.28 | 1.09, 1.51 |
| | CO+SO2+O3 | 1.04 | 0.90, 1.21 | 1.05 | 0.89, 1.23 | 1.27 | 1.08, 1.49 |
| | NO2+SO2+O3 | 0.97 | 0.85, 1.12 | 1.04 | 0.88, 1.22 | 1.30 | 1.11, 1.5[a] |
| | CO+O3+PM2.5 | 1.19 | 0.92, 1.54 | 1.06 | 0.79, 1.42 | 0.93 | 0.72, 1.19 |
| PM2.5 | CO+O3+PM2.5 | 0.97 | 0.85, 1.11 | 0.99 | 0.86, 1.13 | 0.91 | 0.78, 1.07 |

[a] Significant at the 5 % level.
Note: OR = odds ratios; CI = confidence intervals; CO = carbon monoxide; NO2 = nitrogen dioxide; $O_3$ = ozone, $PM_{2.5}$ = particulate matter, particles of diameter <= 2.5 microns. The results are reported for the IQRs listed in Table 1. (Warm: April – September, cold: October – March).